MAIN CURRENTS

IN MODERN THOUGHT

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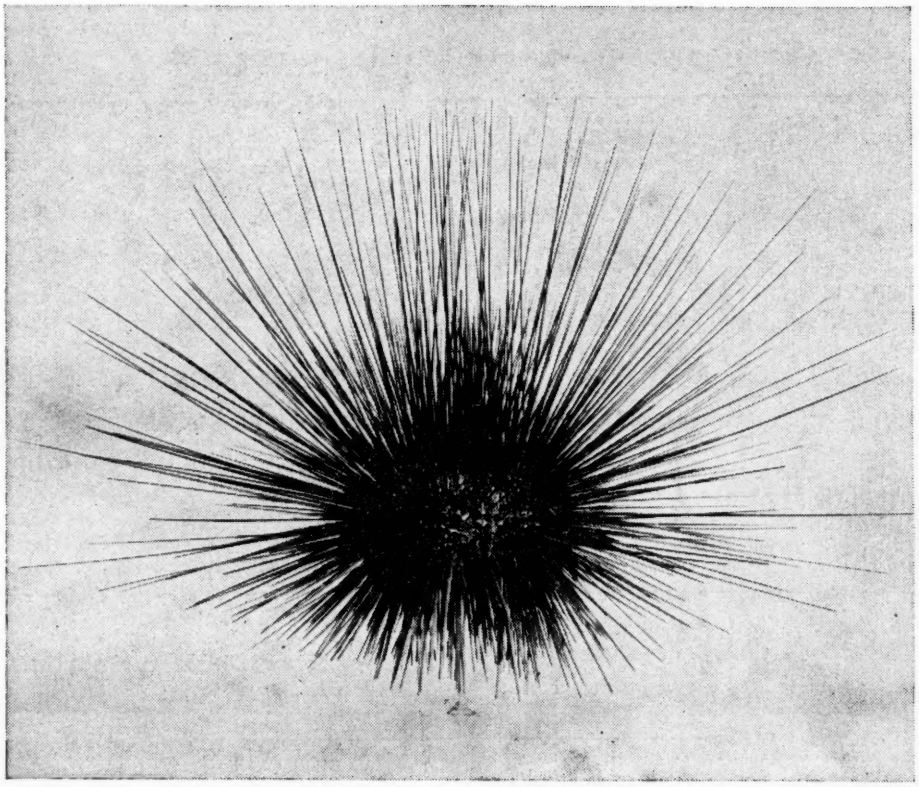

See inside cover

Courtesy of the American Museum of Natural History

VOL. 10 NO. 3

MAIN CURRENTS IN MODERN THOUGHT

A co-operative journal to promote the free association of those working toward the integration of all knowledge through the study of the whole of things, Nature, Man, and Society, assuming the universe to be one, dependable, intelligible, harmonious.

VOL. 10 No. 3 JANUARY, 1954 50 HILLANDALE ROAD, PORT CHESTER, N. Y.

PUBLISHED 5 TIMES A YEAR IN SEPT., NOV., JAN., MARCH, AND MAY.

Editor: F. L. KUNZ Associate Editor: E. B. SELLON Assistant Editor: MARIFRANCES ORSER

The Journal of the Foundation for Integrated Education, 246 East 46th St., New York 17, N. Y.

CONTENTS

Genetics and Morphology	Clarence Cook Little	51
A Definition of Freedom	Howard L. Parsons	57
Integrative Programs in Colleges		61
Trends in Engineering Education		61
General Education at North Carolina State College		62
Source Readings: Integrative Materials and Methods		64
Reviews		67
News and Notes		70

The cover photograph is of a sea urchin, *Contrechinus Antillarum* (Phillipi), *Phylum Echinodermata.*

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GENETICS AND MORPHOLOGY*

Clarence Cook Little

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A Contrast of Triumph and Defeat

The topic of our discussion this evening is a challenging one. It is much more difficult to speak with definiteness and finality of triumph and defeat in biology than it is in physics or mathematics. However, I shall accept the challenge and shall try to bring the two great disciplines of biology, genetics and morphology, together towards the close of my remarks.

Since we are to discuss the relative progress of research in these two branches of biological science, it will probably be well to define briefly what we shall take to be the fields covered by each.

Genetics deals with all those structures and processes involved in the influences exerted by a parental organism upon its descendants, upon dependent and subsequent generations. The problem is subject to a recurring concentration in each generation, as hereditable material must be localized and contained in the mature *germ-cell,* a microscopic unit. This concentrated phase is the stage at which parental influence makes itself felt most obviously. In the viviparous and lactating mammals, there are, however, two other stages, the embryonic and the neo-natal, in which parental influence can also be exerted upon progeny which are not yet capable of independent existence, except under artificial protective conditions.

During the period of development inside the mother's body, the *uterine environment* determines entirely what external influences the embryo experiences. This rigid control has obviously been preserved most jealously by nature, as the degree of protection of the developing organism at that stage is too great to be due to chance alone. There must be valid reasons why constant conditions are maintained during these formative and impressionable periods of the organism's development. In addition, during the *neo-natal period,* the sole nutriment obtained by the normal mammal is the milk of its mother, and that milk varies greatly as to its vitamin and hormone content in different individual mammals and in different strains of mammals. This is also a very important parental influence and is, to my mind, rightly to be considered a part of genetics, since it is an aspect of that primitive contact with the parental generation which determines what characteristics the new individual organism will possess.

Morphology is the history of progressive development and differentiation of the individual organism and the analysis of the factors which determine the course and extent of the processes involved. From the first division of the fertilized ovum, morphology faces and deals with a steadily increasing number of cellular units. These form an internal environment where intercommunication between cells, tissues, and organ systems becomes progressively integrated, complex, and successfully concealed in the whole, beautifully organized balance and functioning of the individual.

In the study of a developing embryo, it is not at all difficult to observe the origins of different organs or to detect tissues being formed, but as the organism grows and more cells appear, these systems become coordinated into a subtle organization in which a great many of the morphological influences are not visible to the eye. They take place in the form of functions and of interrelations between structures that were themselves identified some time previously. Because of this fact it is not surprising that scientists have focussed first on genetics, which is concerned with the things that can be seen, dealt with, and measured directly.

It will be readily seen that both of these two fields of research, genetics and morphology, are really vital. Either alone forms only one of the foundation stones of our understanding, analysis, or utilization of the individual. Together, the two offer a challenge to the investigator which is closly akin to, and inseparable from, our progress in understanding whatever our intellect can grasp of *life itself.*

For on the one hand we are studying the continuum of life, the unbroken thread that has existed from the first physical organism up to man, and we are trying to decipher what each generation has contributed along that evolutionary road. Thus genetics is immensely important to us in our effort to understand life, for we must know with what we start. On the other hand, if we con-

* A lecture delivered at the 1953 workshop of the Foundation for Integrated Education, co-sponsored by the University of Maine.

sider this other miraculous process of differentiation and of form-producing, we realize that in this extraordinary phenomenon must also lie a clue as to what life itself is. We understand little as yet about this process of differentiation. Yet we may be able to return to the important milestones in morphology later, when by research we have acquired more knowledge and new techniques, and gain from them a rich harvest. Let me illustrate with one example.

Many years ago marine biologists found that in the fertilized egg cells of certain organisms of the starfish and sea urchin type, the cytoplasmic substance of the egg as well as the mystical and thrilling nucleus had a great deal to do with the determination of form. In a particular species of sea urchin, although the nucleus was removed, the embryo nevertheless formed. Even though the larva did not fully mature, the cytoplasm was able to start its development. This demonstrates that one must not focus on the nucleus to the exclusion of everything else, but must consider the cell as a whole, as a system.

Much later, the brilliant work of Spemann and his school showed in the developing organism several substances that he called "organizers." These arose in little groups of cells that could influence the growth and differentiation of other cells which lay far beyond their own area. For example, if the organizer's function was to form an eye, it would form an eye, even when transplanted to another part of the body. The organizer could influence cells which were intended to be leg muscle, and make an eye out of them.

Such things as these are both exciting and tantalizing to biologists. Here is a focus of great organizing power, and yet we can't explain its origin or behavior, nor do we know how to harness it. It is true that we might have expected such creative power in certain cells, because for a long time we have observed the process of regeneration in many of the lower vertebrates such as the amphibia. If in the embryo of a newt or salamander the limb bud is cut off, the animal can grow a complete new leg out of tissue that was never intended to perform such a function. But *why* this happens has never been explained.

Dr. William Russell has recently done some fascinating experiments with mice. Mice normally have five lumbar vertebrae, but in one strain used in the laboratory the mice commonly have six such vertebrae. Fertilized mouse eggs can be transferred from their own mother's body into the uterus of a foster mother, where they develop. In these experiments, eggs that should have developed into six lumbar vertebrae mice, since they had been liberated and fertilized in a six vertebrae mother, were put into the uterus of a five vertebrae foster mother. The extraordinary result was that the baby mice were frequently born with five vertebrae instead of six. The opposite also held true: the eggs from a five vertebrae mother, transplanted into one with six, often produced young with six vertebrae. We are thus forced to the conclusion that the uterine environment (which had been largely ignored heretofore) is a tremendously important morphogenetic factor. The fact that uterine environment can interfere with genetics, and transform an animal into a different type, makes one wonder how much we have neglected and overlooked in this type of maternal influence, which is a true parental influence of a basic sort.

Obviously genetics and experimental morphology must go hand in hand as research progresses. If the former defines what genes the germ-cell can carry, the latter describes how the genes express themselves. If morphology is concerned with various environmental influences, both internal and external, then genetics has a voice in determining the limits to which those influences can modify what heredity provides.

Our discussion of genetics' "triumph" and of morphology's "defeat" must, therefore, be tempered by the realization that the employment of those terms is distinctly a relative, rather than an absolute usage. As we review more of the things that have happened during the course of research in each of these sciences, we shall see how true this is.

In 1900 our knowledge of genetics was a strange mixture of data and dicta derived from breeders of domestic plants and animals. There had been many efforts to describe a whole organism, used in breeding experiments, as though it were a unit; and a statistico-biometric attempt to develop general laws or rules by the analysis of these records and impressions which were unsatisfactory and often inaccurate.

Then came the rediscovery by scientists of results that decades before, by the happy and fruitful combination of mathematics, botany, and isolation, had been recorded by the Austrian monk, Gregor Mendel. He had the wisdom to analyze, character by character, the results of crosses between morphologically distinct varieties of the garden pea (round or wrinkled, yellow or green), which was ideal for that particular purpose and combination of circumstances. As a result of his experiments he formulated two laws which have withstood the test of time: segregation (hereditary bases of roundness or wrinkledness are units and do not affect one another) and random recombination (second generation germ cells come together at random, by the law of chance).

The first use of Mendel's laws by other researchers was confined, as it was at first with its discoverer, to characters which were so clear-cut and definite that they gave a sense of scientific security to those who were investigating them. The classical experiments of Castle and Phillips, using genetically different color-varieties of the guinea

pig, seemed to support, without the need of any qualification, the theory of purity of the germ cell.

It was on this early foundation of experimental work that Morgan used the discovery of the white-eyed mutant of *Drosophila* to lead the trend of genetic research to that species. Because the fruit fly *Drosophila* has the happy faculty of producing a whole new generation in ten days, it is wonderful material for the study of genetics. Morgan was working on a population problem when, among the thousands and thousands of normal red-eyed flies that he was raising, appeared a sudden variation, one with white eyes. From the study of this mutant, and later mutations of the species, came the tremendous advance of mathematical genetics — a genetics with a predictable basis.

On a development of this research was built the chromosome theory of heredity. Morgan and his brilliant students, Bridges, Sturtevant and Mueller, added to Mendel's original laws. Mendel had discovered the principles of dominance, random assortment and independent segregation. Morgan and his group added "linkage," and "crossing over" of genes, their arrangement in linear order in the chromosomes and the limitation of the number of linkage groups of genes to the number of chromosomes.

Linkage means the association of genes in the same chromosome. They travel together in the majority of passages between one generation and the next. "Crossing over" means that, on occasion, the association between genes is broken. By the careful study of these two phenomena, Morgan and his associates began to develop a picture of the physical location of the genes. This location proved to be sufficiently definite to allow both mathematical prediction of results and establishment of a basis of continuing relationship of genes, both of which proved to be correct and reliable.

The physical structures which fulfilled all the requirements of the observed experimental facts were the chromosomes. Chromosomes appear in the cells of every animal, and they are constant in number for each species. In every sex cell of the fruit fly there are only four chromosomes; in the sex cells of mice there are twenty; in man there are twenty-four. Needless to say, these are not the same chromosomes, but there are constant numbers in the sex cells of every animal. It was also found that the number of groups of associated genes corresponded exactly with the number of chromosomes. From these facts Morgan developed the chromosome theory of heredity, which proposed that the chromosomes were the vehicles in which the chemical units, the genes, were located.

This theory was brilliantly proven. The spatial relationships and associations which the genes or hereditary units should have to one another were determined by scores of breeding experiments, by many investigators. Then Painter and Bridges, both of whom had a genius for observation, found that in the case of the minute salivary glands of the tiny fruit fly with which they were working, the chromosomes were approximately 100 times as large as those in any other part of the body.

They knew the spatial relationship of genes, and they found, under the microscope, band-like structures within these large chromosomes that corresponded with the genetically proven distances between the identified genes. They also found that the number of groups of linked genes always corresponded with, and never exceeded, the number of chromosomes. Also the actual size of the individual chromosomes, of which in *Drosophila* there are only four pairs, was reflected in the number of identified genes in each, and in the closeness of association of one gene to another in inheritance.

All in all, there came out of this magnificent analysis of *Drosophila,* the framework of the orthodox and basic philosophy of Mendelism. It was comfortable, satisfactory, and it appeared to be, to all intents and purposes, complete. The chromosome theory of heredity was established, and this constitutes the "triumph" of genetics which our title mentions.

But, and this is an unpleasant and hungry little word, the problem had been attacked and "solved" in insects, which have a helpful factor of being essentially a mosaic, fixed, and inelastic structure. This holds true from the formation of the germ-cells to the developmental completion of the finished adult.

Mammals, of which group man is unfortunately a member, are not nearly so obliging in their cellular definiteness and integrity. In the process, the amount of "crossing over," and in the relative indefiniteness and variation of linkage, mammals, from the first, gave a clear warning that they were much more individual and unpredictable than were the insects. A mammal is an extraordinarily coordinated organism in which the interchangeability of body fluids is extensive. We are aware of the immense significance of the glands of internal secretion in a mammal. Sex hormones for example create the enormous difference in form between a bull and a cow — otherwise essentially the same animal. In the same way we observe some of the extraordinary types of human beings that result from abnormal pituitary secretions or from over- or underactive thyroids. There is a good deal of very interesting evidence that a mammal is an interchangeable organism, quite different in many ways from an insect. It is not surprising that this baffling freedom of exchange between the parts of the mammalian body and between cells continues to pose to the geneticist questions which the orthodoxy of evidence derived from forms

with more localized and limited biological capacity fails to answer.

Some investigators can honestly be content working out the biological moves in the chess game of intra-chromosomal genetics in simple forms of life. It is no mean challenge in its inception or achievement, or in its solution. On the other hand, unless and until the principles and conclusions arrived at are shown to be transferable in detail to mammals, some of us must continue to feel a reasonable conservatism and to keep on working in genetics with the best type of relatively slow and resilient mammalian material itself. This is done in the belief that the role of genetics in such an internal environment and during the dependent developmental phases of mammals is subject to characteristic influences which in themselves are of prime importance in determining the nature of individuality.

Since life, as we can observe and analyze it, consists of a series of processes, the old criteria of recording and measuring structures representing end-points are not dynamic enough to give a satisfactory picture of what is taking place as a process. With uncontrolled, variable material, morphology is tremendously handicapped, because what might hold true of the development of one mammalian individual would have to be seriously modified to explain the form of another. It is at this point that genetics has come to the rescue of morphology in an exciting way, and I should like to spend a few minutes in discussing it.

Genetics can do something besides sort out chromosomes and genes. Years ago a Danish botanist named Johanneson worked out a mathematical theory which stated that if an experiment is made with heterogeneous material, of 50% variability, and that material is inbred very closely — brother to sister, or parent to offspring — after a given number of generations the hereditary variability will be reduced from 50% to about .4%. In other words, if we consider the domestic mouse, 99½% of the hereditary variability would be eliminated by a process of inbreeding for twenty or more generations.

This is just what has been done. We started inbreeding mice a long time ago. Today there are sixty or more inbred strains of mice, and within each strain there is as much uniformity as if every mouse in that strain was an identical twin of every other. Thus, instead of just having to wait for two human individuals that are alike, we can get 5, or 50, or 5,000 or 50,000 mice that are all exactly alike from one strain, which we might call strain A. In strain B there is just as much uniformity, but its characteristics are quite different from those of strain A. These strain B mice will grow old in a different way, put on weight instead of staying thin, become sterile much more rapidly than others, have earlier litters, but not such big ones. Whatever may be the differences, each strain has regular patterns of developmental behavior from the fertilized egg up to adulthood and death, which can be closely predicted and which may be said to be characteristic of that strain.

Let us think of what this will mean to morphology. If morphology can hold heredity constant, by using the inbred strains, it can then subject the fertilized egg, or any stage of the organism, to whatever experimental procedure may be desired. If then the form or structure of the animal, or its life history or behavior are changed, it will be because of what the experiment did to the animal, and not what the animal was born with. Thus, on the one hand we can hold the genetics constant and vary the environment, the morphological factors. On the other we can try to hold the morphology constant and subject different genetic strains to a single experimental procedure. In other words, we can play constant heredity against changed morphological factors, or constant morphology against different hereditary backgrounds.

On that basis of the partnership of genetics and morphology, I believe that we can and will make tremendous advances in knowledge of both disciplines. To my mind, it has been remarkable that the morphologists have been able to find as many general leads as they have done, when one considers that they could not accurately repeat their experiments or predict what might happen in another strain of higher animals. Now that repeatability is possible, it seems to me that we are going to be able to advance rapidly in analysis of the field of morphogenesis.

A number of lines of evidence from both invertebrates and vertebrates show that the relationships between the cellular, tissue, and organ components are, within recognizable limits, defined, and result in an organized and self-perpetuating *balance,* which is characteristic for what we call "normalcy." The study of this balance and the results of its experimental upsets are now a promising and developing field. The healthy adult mammal is in such a state of balance. Not only does it repair its worn-out tissues as it needs them, in a sort of pseudo-regeneration which is wonderfully effective, but it also is able to keep the pendulum of use and disuse, of supply and demand, swinging within controllable limits.

I have frequently been asked whether I feel there is any evidence of purpose in organisms. I do indeed think that in order for a living organism to survive with the full expression of its life it must have purpose, although it usually is not aware of it. One constantly finds an impulsion on the part of the organism to restore its balance. Why is it that when a sponge, one of the lowest organisms, is put through cheesecloth until it is

nothing but a mass of jelly at the bottom of a dish, it will reform itself into a sponge? This is certainly an exhibition of purposefulness: a return to the point at which the organism can again function with balance.

That state of balance is health. But now, having genetic strains of animals in which we know what the behavior will be when health is maintained, we can do peculiar things. We can invade the internal environment and perform morphological experiments. By deliberately creating unbalance between various component substances produced within the body and/or known to influence growth, we can observe variations against a constant genetic background.

Let me give an example from our experience at the Jackson Laboratory. We had three distinct inbred strains of mice, which had not been related for fifty to one hundred generations. From each of these strains we took new-born mice (each of which is about as big as the end joint of your little finger), anesthetized them, and removed the reproductive glands. We performed this operation because we wanted to find out how it would affect the incidence of mammary cancer in these mice. However, as so often happens in scientific research, we became most interested in other aspects or byproducts of our experiment. One strain, which we may call A, behaved quite properly, as animals without reproductive glands should. Their secondary sex organs did not develop, and the mice remained juvenile just as the textbooks said they would. But the second strain, B, surprised us.

The first thing we noticed was that they began to form mammary cancers. This was a high cancer strain, but we did not expect them to develop cancer, because if they remained juvenile and undeveloped, theoretically there would not be enough breast tissue on which to form a cancer. On examination, however, it was found that in these mice the breast tissue was as well developed as if they still had their ovaries. They actually had no ovarian tissue whatever, but we discovered an amazing thing. The two little glands called the adrenals had "taken over" for the ovaries and were secreting a hormone very much like the female sex hormone. Under the stimulus of their secretions, the uterus and the mammary tissue developed as though there really were ovaries present and functioning.

In the third strain, C, still other things began to happen. Everything went along normally in the early stages, when all at once *these* mice began to masculinize. The males tried to mate with the females; they became pugnacious and fought among themselves as normal male mice usually do. A little later they developed palpable lumps over the adrenals. On operation, we found that not only had the adrenals become active, but that there was cancer of the adrenals in every case. Those tumors could be taken out, and secretions from them could be used to masculinize castrated male mice. In other words, the adrenal tumors were secreting male hormones just as successfully as the sex gland itself could.

In this experiment the morphological procedure was held constant and the normal, healthy endocrine balance experimentally upset. By such a process, one may obtain information as to how three different, but still controlled, genetic constitutions (strains A, B and C) respond to a single identical alteration of the developmental environment (in this case, removal of the reproductive glands). I believe that experiments of this kind, in increasing number and with more planned consistency than was present in this entering wedge, will show what the science of genetics can do for morphology. Ten years from now these two aspects of science will doubtless be much more nearly equalized, and the form-determining factors and the forces that cause them will be better understood.

So far I have talked purely materialistically about the analysis of life. However, it is debatable whether this is the entire philosophical interpretation. I personally believe that life is more than a mere combination of chemicals, and that the idea of emergent creative forces is at present nearest the truth so far as the observations of biology are concerned. Probably the best we shall ever be able to do towards defining life will be to describe that which is describable, that is, what is chemical, what is definite: the basis on which forces work.

Life itself will doubtless continue to escape us, because it is a dynamic force. Since our minds have to break things down and categorize them before we can describe them, it is doubtful whether we shall be able fully to *understand* the dynamics of life. We will probably be able to discover a great deal of what goes into the reactions that turn out to be living organisms, but I do not see any prospect as yet of terminology that will enable us to describe the essence of a continuing and changing process. It is true that we can isolate and define resting points in the process—its start, for example, or certain points along its progress. But the moment we select a *point*, we have struck the balance, and the continuity, the essential active force which is the basis of life, eludes us.

The problem certainly becomes more complicated as we study higher forms of life. As I said before, *Drosophila* did not entirely prepare us for mice. The definite bonds of internal organization which we find at the threshold of life, in lower organisms, become looser and more versatile as we climb the evolutionary ladder. When we have to deal with a central nervous system, a storehouse for impressions, memories, and so on, it becomes much more difficult to locate or describe life processes definitely. Intangibles enter the picture. When we

come to man, the case is certainly further complicated. In us, the physical phases of life build up to the mental and emotional, and then something, which we may call the spirit, takes over. What this may be I don't pretend to know, but it has certain attributes which should be recognized.

Many people expect that spiritual forces will be subject to the same degree of control by the intellect that is exerted on mental and physical qualities. It would seem to me by definition that all through life a lower level of organization can experience, but never grasp, a higher one. If we work up through all levels, from the beginning of nervous impulse, through the formation of de-centralized and then centralized nervous impulses, the arrival of reflexes and responses, behaviors of different kinds, up to free will, intellect, language, the free exchange of ideas—all the way along, the organism lower in level can *experience* the higher one but can never grasp or comprehend it.

When the amoeba is swallowed by a fish, he certainly experiences the fish: he runs into an acid medium which turns him into digestible material. But the amoeba has no understanding of what it is that has engulfed him. On the other hand, the fish not only experiences the amoeba in the act of eating him; he knows a good deal about the amoeba, for he is able to hunt for, and find him. The fish not only experiences the amoeba, but also "understands" and uses him in a biological way.

The human angler has a similar, but greater, knowledge about the fish. He studies the trout thoroughly, learns his feeding habits and his likes and dislikes, and manufactures a fly to suit. When one day the trout takes a hook into his mouth, he experiences the intellect of man very vitally. But even if he manages to escape, all he can do about it is to shy away from that kind of fly again—and the angler can make a different one. The trout cannot understand why that fly was associated with a sharp hook, or where it came from, or even know that a man had intended to catch him. He couldn't understand the intellect at all, although he experienced it vitally.

In the same way we humans experience what we may call spiritual things, such as intuitions, feelings of love and sorrow, appreciation of beauty, religious aspiration. We *experience* these things often unpredictably, and they are very real to us, but we don't understand them. To attempt to define them, measure them, and label them intellectually seems to me as illogical and unsuccessful as it would be for us to expect the amoeba to do the same for the fish.

So at this stage of our knowledge I prefer to accept these spiritual aspects of life happily, simply, and without definition. To my mind, the moment we try to put a stamp on life, to identify it, to possess it intellectually, we isolate its beauty and power from others who do not quite follow us along the details of our thinking. That, perhaps, is one of the reasons why I look upon biology, upon our study of life, as a journey, rather than as a goal.

In case this seems to some to be a negative point of view, it may come as some comfort to realize that even if there is little prospect that the biologist will be able to explain this creative, emergent life process, there is really no *need* for him to do so. The important thing is that he can give the world knowledge of what each generation is born with. Sociology may indicate that the training and environment of man has made the difference between civilization and its lack — which we all will admit gladly — but the biologist will remind us that we cannot think of the individual as a blank blackboard on which anything can be written. Unrestrained exuberance for environment (such as that shown by Lysenko and his satellites) is as far off the course as is the uncompromising worship of the gene alone, by the ultra-orthodox Mendelians. The old adage that the truth lies somewhere between will undoubtedly become more and more evident and applicable as time goes on.

It would seem, therefore, that genetic progress might be described as a still-continuing *advance* on all fronts, and that morphogenesis has shown a scattered distribution of areas of complete *checkmate,* and of *point* or *local* advances with few coordinating or integrating plans of campaign.

In this analogy it is well also to remember that genetics has found, beyond the rigid lines established by the rapid advance of the chromosome theory, great bodies of other "parental influence" problems, such as cytoplasmic, uterine, and milk agents, that will certainly modify our concepts of the relationships between parent and offspring, and between the gene and its finished expression, the character or function.

Morphogenesis, on the other hand, now possesses for the first time a wealth of mammalian material in which the successful inbreeding technique of genetics has reduced to a minimum the genetic variables, and has thus provided relatively constant hereditary backgrounds against which the experimental modification of the developmental and differentiating processes should stand out with new distinctness. This should mean much more rapid advances, both qualitatively and quantitatively, in experimental morphology.

Thus "triumph" for the one science and "defeat" for the other are tempered and modified to a healthy and heartening birth of cooperation between the two. The discoveries of experimental morphology will hereafter give a sense of respectable humility to the too orthodox geneticist. Genetics, in turn, will give a foundation of predictable developmental patterns to provide a degree of regulation and control not hitherto available to experimental morphology.

A DEFINITION OF FREEDOM*

Howard L. Parsons

University of Tennessee

Nature Provides; Man Improvises

A free person is one who has learned how to learn, who has formed habits of freedom. But the "habit" of freedom is different from the habit of neurosis or psychosis. It may be likened to a parabola, or (better) a hyperbola, an upward spiral; whereas the habit of an illness, unlike the (ideal) linear destiny of a thrown stone, moves downward into increasing and narrowing fixity. If we accept the biological truth that "Even repetitive processes are not circular in pattern; they are spiral," [1] then we are confronted by a deep-lying duality in nature: the spiral which tends toward increasing order-and-sentience, and the spiral which tends toward increasing entropy-and-non-sentience: freedom and slavery. The neurotic is *compelled* to do as he does; his anxiety produces protective action which in turn is anxiety-producing; he is thus caught in a hopeless dilemma, moved by causes outside his control into avenues of inevitable suffering and eventual death. Such a demoralizing spiral he cannot himself, "of his own free will," break. What could be greater slavery?

While the neurotic behavior is *driven* by fear of self, of others, and of the world, free behavior is the spontaneous outreach of the organism toward completion of needful tendencies organically related to the whole personality. Neurosis is self-defeating in a double sense: it defeats the specific needs in question, and it defeats the healthy growth of the total self. But freedom is self-perpetuating *and* self-expanding. It is not uncaused; indeed it is caused, and caused by the will to assimilate new values, and by the loving care of the mind for the self through the exercise of memory and foresight. Karen Horney says:

> When we call a drive compulsive we mean the opposite of spontaneous wishes or strivings. The latter are an expression of the real self; the former are determined by the inner necessities of the neurotic structure . . . the difference between spontaneous and compulsive is one between "I want" and "I must in order to avoid some danger." [2]

Risk is the essence of freedom, for risk is involved in uncertainty, novelty, initiative, and decision. But safety within known and pre-established limits is the rule of slavery, whether one give the rule or receive it.

The upward spiral of freedom is the spiral of increasing spontaneity and control – as novelty advances only with design. With twelve thousand million nerve cells – and with what Sherrington has shown to be the uniquely permeable character of the synoptic membranes – man's possibilities for development are practically infinite, never remotely approximated by an individual in his lifetime. In a similar way that number theory, as shown by Goedel, is incompletable, so man is incompletable. Theoretically, where theory is not governed by experience, anything is possible – for example, number theory can be completed, experience can be systematized, man can be perfected – i.e., can attain a final form of satisfaction embracing all his possibilities. But, such impossible theory aside, in actual fact man can never be perfected because his infinite possibilities are conceived, born, matured, and finally destroyed only in a finite bodily process in a finite situation. Man's development occurs within limitations; it is a movement from narrow limitations and latitudes to less narrow ones. It is "free" movement within the bounds of necessity, as a quantum leaps unpredictably from one determinate orbit to the next. And freedom advances through the recognition of such necessity. Like other organisms, but more than other organisms, man moves beyond local and provisional limitations; he is forever aligning himself with powers and purposes wider in extent, deeper in quality, more pregnant in possibilities, and more durable in time, than those of his past. Freedom is rooted in man's insatiable thirst for adventure; and even if the world were finite, in time to be exhausted by man's explorations, man

* This is the final section of a longer unpublished paper.

1 Herrick, C. Judson, "A Biological Survey of Integrative Levels," in Sellars, R. W., McGill, V. J., & Farber, M. (Editors), *Philosophy for the Future*. New York: The Macmillan Co., 1949, p. 240.

2 Horney, Karen, *Neurosis and Human Growth*. New York: W. W. Norton & Co., 1950, p. 29. Luther says a similar thing in *The Bondage of the Will;* see *A Compend of Luther's Theology*. Edited by H. T. Kerr. Philadelphia: The Westminster Press, 1944, p. 89.

would then need to occupy himself in "adventures of ideas."

The behavior of the free man cannot in any sense be considered compelled as a physical body is compelled. Who will say that freedom can be defined by Newton's law:

> Every body perseveres in its state of rest, or of uniform motion in a straight line, unless it is *compelled* to change that state by forces *impressed thereon.* (Italics mine)

Freedom is distinguished by forces *from within* working changes outwardly, by tender movements and thread-thin ideas, by needs which emerge and reach fulfillment or transformation and run their course, by dreams which are entertained and dramatized on the inner stage of the imagination, to be in time freely enacted. Freedom begins in disturbance, hesitation, doubt; it involves a gradient and delayed response to the world. It is made possible because the environment is internalized and the personality includes and indirectly makes its own environment. Walking and talking manifest such gradient response. This response may be very precise in its effects, as when we tell ourselves at night to wake up at five o'clock, and do; or it may embrace long time-spans, as when we orient ourselves to endure arduous tasks whose completion lies years, even centuries, away.

Organisms throughout the history of life have increasingly internalized and controlled their environments; [3] and this has been the natural history of freedom. Such control, as Simpson suggests, "is rather the ability to cope with a greater variety of environments than lessening of dependence on environment as a whole." [4] For example, my ability to dispose myself to respond to a world to be encountered in the future renders me less susceptible to control *by it.* As organic evolution proceeds by "change in the direction of increase in the range, variety, and efficiency of the organism to its environment" [5] through such mechanisms as sex, care of the young, and the interaction of specialized functions or individuals – so cultural or personal evolution proceeds by the language interaction of men. A man communicates with others, and so, by internalizing social processes, communicates with himself. As he is freed and controlled in his relations with others, he is freed and controlled in his relations with himself. Carl Rogers and others have amply demonstrated this. An autonomous individual is an intensification of the evolutionary process: the progressive control over environment through the knowledge of needs, the envisagement of ends, the knowledge of means, and the access to tools and materials for realizing ends. Such autonomy can be defined only contextually, where individuals in their autonomy are interdependent with human society, with cultural and technological processes of history, and with the destinies of the rest of nature.

The common tendency of organisms is self-maintenance; and in a creature like man, whose self with its needs and values is in constant process of transformation, this tendency itself becomes transformed into the tendency of self-development. For to maintain his true self, which he can never really discover because it is forever unfolding, man must develop – or die. Accordingly, man accepts what he apprehends to be conducive to his development, and rejects what is obstructive to that development, screening out external perceptual possibilities and suppressing awareness of internal processes which are disruptive of development, while at the same time actively seeking and favoring, outside himself and inside himself, those processes which he considers to reinforce, extend, integrate, and elaborate the developmental tendencies already at work.[6] Such selectivity in self-maintenance explains both healthy and unhealthy behavior.

Though each man has to discover and invent for himself the character, specific quality, direction, and pace of his own peculiar line of development, every man learns the common techniques of development from others, incorporating these into his own imagination and behavior. What is incorporated? The dialectic, the interacting of roles, the verbal strife, the "conversation of the soul," the sublimated warfare which is the mother of all things. If in his relations with others a person is cared for, respected, and treated with sensitivity and intelligence, then he in turn will tend to treat his own emergent self with care, respect, sensitivity, and intelligence. Conversely, if others reject and hate him, he will tend to reject and hate himself. As already observed, frequently the novelty necessary to freedom emerges in the tension of opposites; the reconstruction or creation of the personality is carried on through the production of signs and roles which then act back on the old self and call forth new responses. Thus the free man is receptive to meanings and roles (both fictional and actual) as these impinge upon him; he "entertains" such guests in the mansion of his imagination, permitting them all the necessities for the fruitful interplay of opposite perspectives: leisure, non-interference, quiet, amplitude of movement, attentiveness in following the leads and openings of the dialogue, courage before conflict, rest, and all the other meat and drink requisite to their mutual discourse. Indeed, he has learned from others how to play the part of a cordial host to a party of diverse temperaments: he himself has experienced with others such a symposium and dialectic,

[3] See Redfield, Robert (Editor), *Integration in Biological and Social Systems.* Lancaster, Pa.: Jaques Cattell Press, 1942.

[4] Simpson, George Gaylord, The Meaning of Evolution. New Haven: Yale University Press, 1950, p. 251.

[5] Herrick, C. Judson, *op. cit.*, p. 227.

[6] Sullivan, Harry Stack, *Conceptions of Modern Psychiatry.* Washington, D. C.: William Alanson White Psychiatric Foundation, 1947.

the consequence of which is novelties and integrations such as one man alone, in the privacy of isolation, could never foresee. Thereby one calls on the resources of several points of view: one re-enacts in a unique way the external dynamic of interaction. Whereas in the latter one is forced to take account of one's opponent and adjust to him, often under a compulsion which cannot be freely assented to; in the drama of the soul one may, in the peace of quiet passiveness, voluntarily enter into the conflict of opposites – although, as Emerson remarks, the great man may keep a perfect peace in the midst of the crowd. Once having tasted the first fruits of freedom, a man may then continue to enter into creative dialogue with himself, as this is fed and sustained by dialogue with others, precisely because it is enjoyed for its own sake. And that intrinsic enjoyment, voluntarily chosen and cherished, is what stamps it as an experience of freedom.

The slave lacks those social relations and material relations in which external and internal controls can free him from blind necessity. A slave is one deprived, by his environment, of knowledge, power, sensitivity. He is in bondage because the slavery of his masters, who exert compulsion because the whole system compels them, requires it. Ignorance, material deprivation, organic defect or disease or atrophy: these are all traceable to social relations and material conditions which determine and are determined by those relations. In what sense, then, can the brutalized peasant or the neurotic be held responsible for their states and actions? (The neurotic is the harder case, for while he seems to exhibit some marks of freedom yet he lacks it in crucial tests; the peasant is the exceptional case, for only sporadically does he endeavor, like Prometheus, "to defy Power, which seems omnipotent.")

Historically, the problem of fixing responsibility has been the problem of a group's preserving itself against destruction. Responsibility was a matter of rationalizing punishment for the enemies to the society. Thus common people in their misdemeanors have more frequently been called before the court of responsibility than have the ruling classes in their crimes. With the onset of science and the understanding of cause-effect relations, the notion of responsibility has tended to disappear into determinism of a sort that erases both freedom and responsibility. Freud's love-instinct and death-instinct is only a half-way house. But recent psychiatry, while not denying causal forces or the duality of human tendencies, has re-instated the concepts of freedom and responsibility. A person is free and responsible where there is still a will to grow and a knowledge, if only dim, of alternatives of better and worse. This is purely an operational definition of freedom, for the psychiatrist will take no one for treatment who lacks a genuine desire for change for the better, and who lacks the tools in knowledge for effecting change. (Psychiatrists fail to require an equally important factor in the therapy of freedom: a culture whose material goods will facilitate freedom, and whose social relations will sustain and nurture it.) More and more psychiatrists are coming to say with Sullivan that there is in everyone an innate and indestructible desire for growth.[7]

Our mistake lies in confusing responsibility with external punishment. A person may do wrong; but the truly moral question is not what *has been done,* but what may be done henceforward with respect to doing right. As Dewey explains, evaluation pertains not to the settled past but to the uncertain future – to the discovery of present conditions, like desires and habits and ends-in-view, as these may become effective means to a right end.[8] Rather than indicating punishment, then, a responsible act gone wrong indicates a need for help. For a responsible person is a free person, and a free person will *respond* to the proper help – whereas an irresponsible person, a totally irresponsible or depraved person, if such there be, would be *unresponsive* and could only be checked by physical incarceration or other "inhuman" actions.

A practical morality would mean that men err not because of innately perverse wills but because of misguided wills: they lack the signs whereby to direct their own behavior into progressively satisfying paths. Their wills lack knowledge. Men are not overcome by their own natures (if we believe that they are, what else is there to believe in?); their natures are rather overcome by the barriers of circumstance. As Spinoza says, "All persons who kill themselves are impotent in mind, and have been thoroughly overcome by external causes opposed to their nature."[9] A raw impulse to live, devoid of consciousness of ends, is morally neutral. But is there such a thing? A will is good or bad as it tends or does not tend toward fulfillment of the creative powers latent in the person; prizings are good or bad as they are directed by correct evaluations, as they are informed by true knowledge. A will uninformed is simply an amoral will; but a will informed is a free and responsible one. Can a man know what is good and still not do the good? Yes: he may lack sufficient knowledge of means and ends, he may lack sufficient access to materials and control over conditions, he may lack the strength of driving and yearning need. In the latter case, he may have abandoned the life-struggle, committed the "great refusal." He may kill himself slowly, as in the case of far-gone psychotics;[10] or suddenly,

[7] See Thompson, Clara, *Psychoanalysis: Evolution and Development.* New York: Hermitage House, 1950, p. 128.

[8] Dewey, John, *Theory of Valuation.* International Encyclopedia of Unified Science, vol. II, no. 4. Chicago: University of Chicago Press, 1939.

[9] Spinoza, *Ethics,* IV, Prop. XVIII, Schol.

[10] Deutsch, Albert, *The Shame of the States.* New York: Harcourt, Brace, & Co., 1948.

as in the suicide of despair. Yet if this lack of will, this velleity, is brought about by conditions of ignorance or impotence not in one's control, how can we hold him responsible for it and its consequences?

Against the background of what we know about personality, it is difficult to "fix" responsibility to any one state or act or person. Responsibility is rooted in responsiveness, which in turn is a function of innumerable circumstances. It would seem that freedom is a gift of such circumstances, the conscious control of which depends in turn on creative insight. And this comes to us as a gift, out of the depths of need in our natures. The fact that people differ in their inherent vitality, "effort," or "determination," which they express in the tension of desire, does not mitigate the difficulty. For vitality is, in part, something not in our control, as knowledge is. "The will," as Luther saw, "cannot change itself, nor give itself another bent"; [11] but (contrary to Luther) neither is the will changed by the inscrutable working of an omniscient God; rather, it is changed as concrete conditions can galvanize and move it in new directions. It is changed as the creative acts of innovation and integration occur.

We conclude that, while some men may be fated to be more free than others, thanks to genes and favorable external circumstances, all men are born with the potential of freedom, which may be constricted or released as events respond to the exploratory efforts of the organism by equipping it with knowledge and power. Men fail and fall into slavery because they do not grasp their potentialities, conceptually or actually. In Spinoza's words, "So long, therefore, as one imagines himself unable to do this or that thing, so long is he determined not to do it, and consequently so long it is impossible for him to do it." [12] But what a man can *con*-struct in his imagination depends on how conditions have already *structured* themselves in his concrete existence. Freedom is in the individual the *outcome* of favorable processes of interaction between himself and environment. Similarly, slavery is an *outcome* of living process thwarted in its efforts at development. Psychosis is a severe outcome, in which the individual's life-effort has been rendered weaker because of greater obstacles in the way of development. We are forced to abandon the moral dualism which has dominated our thought for the past 2000 years: it is theoretically false, and it is practically useless in dealing with the problems of human wrong and slavery. "Man has an inherent drive for growth and integration . . . the failure to use it results in dysfunction and unhappiness." [13] Only human wills are good; but human wills grow to be good only as they are facilitated by materials, enlightened by knowledge, and inspired by the comprehensive notion of human development and human freedom — only as they, on the one hand, listen to the prescient stirrings of nascent needs, and, on the other hand, use the tools of knowledge to help in their advance. When we look at nature, freedom is a gift; when we look at ourselves, freedom is something won, a prize. But an undue emphasis on either leads to tyranny and submission on the one hand, and individualism and fanaticism on the other. Freedom is happy union and interplay of mind and matter, of theory and fact, of imagination and necessity, of man's indoor life and his outdoor life, of books and nature. Man remembers, observes, anticipates: he binds time into the space of the immediate present: he feels and knows process in its mechanism toward ends. Thus, to realize his own purposes, he accepts and understands the purposive processes about him and within him; and he then conquers nature by yielding to her.

Nature provides, man improvises: this is his freedom. Or rather, man is nature's highest improvisation, a nature itself naturing, an improvisation ever improvising. Man is most free and creative when he obeys his deepest nature. As an ancient Chinese said, "Only he who makes no distinction between himself and other things and follows the great evolution, can really be independent and always free." [14]

[11] Luther, Martin, *op. cit.*, p. 89.

[12] Spinoza, *Ethics*, III, Prop. LIX, The Affects, XXVIII, Explanation.

[13] Fromm, Erich, *Man For Himself*, p. 219.

[14] Quoted from Chapter I of Hsiang-Kuo *Commentary*, by Fung Yu-lan, *A Short History of Chinese Philosophy*. New York: The Macmillan Co., 1950, p. 229.

"Our American fear of speculative thought comes partly from the growth of irrationalism. This is not a result of the cultivation of abstract knowledge and of the search for wisdom, as university men so often assume. It is rather a product of the loss of belief and even of interest in non-material values and meanings. In a recent essay, Dr. Dewey makes the somewhat surprising assumption that Americans have a peculiar gift for discussion which distinguishes them not only from the Germans but even (he appears to think) from Europeans generally. This is true, if at all, only in connection with the literal discussion of concrete experiences and above all of facts and figures. The example which Dr. Dewey offers is from engineering. It is both because Americans do not take easily to the serious discussion of general principles, and because their idea of the nature of such discussion is largely derived from nineteenth-century Germany, that they fall so readily into the error of assuming that the crisis of the twentieth century has been brought about by too much speculative philosophy." — *The Universities Look for Unity*, by John Ulric Nef, Pantheon, N. Y.

INTEGRATIVE PROGRAMS IN COLLEGES

Trends in Engineering Education And Their Application on One Campus

The Hammond Report on Engineering Education After the War* has stimulated significant developments in a number of institutions, particularly M.I.T., Carnegie Tech, Case, California Tech, Cooper Union, City College of New York, and many others. Some of these institutions have launched quite ambitious integrative programs designed to incorporate the essentials of a liberal education into the training of engineers. Below we summarize some of the points of the Hammond Report and describe development of the engineering program at North Carolina State College.

The Hammond Report enumerated the responsibilities of engineering education "to the public for seeing to it that the students emerge from college with an attitude and background appropriate to effective citizenship as professional men, and that they shall have acquired a sustaining interest in the common welfare and the cultural aspects of community life. Engineering education is responsible to industry for educational programs suitable for professional personnel in engineering and management, and to the engineering profession for the maintenance of proper educational standards and the inculcation of ethical attitudes and conduct among its graduates. Finally, it is responsible to the students themselves for an educational program in which they will be treated as individuals and helped to achieve maximum development of mind and character."

The report recognized two major divisions of engineering education: (1) the scientific-technological, and (2) the humanistic-social. The objectives of the latter were listed as:

"1. Understanding of the evolution of the social organization within which we live and of the influence of science and engineering on its development. 2. Ability to recognize and to make a critical analysis of a problem involving social and economic elements, to arrive at an intelligent opinion about it, and to read with discrimination and purpose towards these ends. 3. Ability to organize thoughts logically and to express them lucidly and convincingly in oral and written English. 4. Acquaintance with some of the great masterpieces of literature and an understanding of their setting in and influence on civilization. 5. Development of moral, ethical, and social concepts essential to a satisfying personal philosophy, to a career consistent with the public welfare, and to a sound professional attitude. 6. Attainment of an interest and pleasure in these pursuits and thus of an inspiration to continued study."

The committee recommended that these objectives could be achieved only "through a *designed sequence* of courses extending throughout the four undergraduate years and requiring a minimum of approximately 20 per cent of the student's educational time."

A sound program of objectives for the scientific-technological studies was felt to include the two associated and complementary elements of critical understanding and power of constructive application. The committee identified the facts and principles of engineering knowledge as generic principles, basic assumptions, empiricisms, derived principles, and specifications and standards, or codes of practice. It stressed that "Critical understanding of them rests primarily upon *recognition of their underlying physical concepts* . . . There is great opportunity to vivify the presentation of these concepts through graphical methods and laboratory demonstrations. It is essential that major principles and concepts be *presented in connection with physical situations* in such a way that the student will learn to recognize the elements of similar situations that are new to him and thus be able to identify the principles that are involved. There are relatively few such principles and concepts but they are applicable to problems in many fields. We believe that an appreciation of this underlying unity in the field of physical science is essential."

The art of engineering was also mentioned: "the necessity for the young engineer to integrate the application of these laws, assumptions, data, and codes so as to accomplish a desired result safely and economically. This requires a combination of resourcefulness, skill, experience, and judgment — amounting at times almost to intuition . . ."

The goals of the undergraduate period were summarized as including "mastery of fundamental scientific principles, engineering modes of thought, basic knowledge in some major branch of engineering, elementary competence in the art of engineering application, some understanding of cost relations, skill in the use of English, insights into social relations and processes, and concepts essential to worthy personal and professional life. The goals of advanced knowledge and specialized technique belong properly to graduate and post-college training."

* *Journal of Engineering Education*, Vol. 34, No. 9, May, 1944, pp. 589-613.

GENERAL EDUCATION AT NORTH CAROLINA STATE COLLEGE

The development of the program at North Carolina State College, Raleigh, is of interest. In 1951, after four years of operation, Dr. C. G. Brennecke gave some of the history of their program in a paper entitled, "General Education for the Engineer (A Second Look)." We quote sections of this report:

"Having settled what was not to be in the program, we tentatively approached the more difficult question of what was to be in it. It seemed to us that the sum total of accomplishment would be a maximum if the student encountered the program early in his college career and carried it through his undergraduate years. Accordingly, we recommended that the program begin with a required course running through the freshman year, that this course be planned especially for the purpose of introducing its students to the humanities and the social sciences, and that this course be taught by a new department, staffed for the purpose. Beyond the freshman year, the Planning Committee did not attempt to make specific recommendations of course content. It contented itself with suggesting that a new committee, to include representatives of both the School of Engineering and of the Basic Division of the College, be appointed to work out the details. It expressed the hope that the entire program would be well integrated (in desperation, the chairman at one time threatened to levy a fine on members using any form of the verb 'to integrate') . . .

"Other committees and administrative bodies took up the work. Our Department of Social Studies was created, and Dr. George A. Gullette appointed as its head. He began at once to engage a staff, and the freshman course of our humanistic-social stem was offered for the first time in the fall of 1947, under the title of Contemporary Civilization, made famous by the Columbia course of the same name, then in its twenty-seventh year.

"Contemporary Civilization, the first course, was given a most ambitious set of objectives to meet. It was to introduce the students to the rich heritage of art and literature available to modern Western civilization, and to the accomplishments of economics, political science, and sociology. It was furthermore to help the student place himself, as an individual and as a future member of the engineering profession, in proper perspective against the world today. Finally, it was to help him develop critical values. At the start, two textbooks were used: Hayakawa's *Language in Action* and Lewis Mumford's *Technics and Civilization,* with the hope that the first would lay the groundwork for the desired critical development (and incidentally help the student to read and understand the second). These two books were supplemented by outside readings, by visual aid materials, and by much earnest effort on the part of the Department of Social Studies.

"The effect on the first class of students, unfortunately, was overwhelming rather than enlightening. Although the objectives were clear enough to the teachers, they did not appear so to those taught, and the result was a sort of puzzled resentment. These difficulties have been overcome, for subsequent classes, by devoting some time at the outset to explaining the purpose of the course (and incidentally of the entire program), and by assembling in offset printed volumes a sufficient quantity of carefully selected readings to serve as a textbook. The present content of Contemporary Civilization is summed up by the Department of Social Studies as follows:

" 'The course begins with a sketch of the evolution of engineering education, and of the relation between technical training and the humanities both here at State College and at other institutions. It then proceeds to a fairly detailed comparison and contrast between the agrarian, pre-scientific society of the Middle Ages, and the scientific, industrial society of the Modern World . . . Special attention is paid to the growth of scientific methods and their applicability to the humanities and the social sciences.' "

We quote part of an introduction to the student from the Contemporary Civilization syllabus:

"The reasons for including courses of this kind in the programs of students whose chief interests lie in scientific or technical fields should be obvious to any thoughtful person. First of all, such studies will help you become better workmen in your chosen fields; they will, like your more technical studies, provide knowledge and training that will prepare you for positions of greater and greater responsibility . . . It is perfectly clear that the man who possesses some understanding of the relationship between his own work and the work of other men in his society, who sees his profession in its economic, political, social, and moral context will have a better chance of success than the man who has technical competence but does not really understand the significance of what he is doing.

"In the second place, whatever your job may be, you are a citizen in a democracy . . . It requires . . . that you keep yourself constantly informed about important public issues . . .

"Finally, your professional life and your life as a citizen will occupy no more than half of your time. You have your life as a member of a family and as an individual human being to consider. The half-educated man is bound to lag behind in

the pursuit of happiness because the number of choices open to him is so limited . . .

"The more specific aim of this particular course is to help you toward a fuller understanding of contemporary civilization, of the basic forces that have made it what it is and that seem most likely to shape its future . . . Future historians may well refer to this as the Age of Science. How was science introduced into the western world? How did it grow and develop? What obstacles did it encounter? . . . What have been and are its relationships to other human activities: to the arts, to religion and morality, to political and social institutions? Above all, what has it done to men's minds and how has it changed our conception of ourselves and of the universe in which we live?"

Dr. Brennecke continues:

"The three sophomore quarters of work in our program are shared between the fields of history and literature. The student may combine the study of world literature with that of the history of the western world since the seventeenth century, or he may expose himself to a combination of United States history and American literature. The courses used to make up the resulting four possible sequences were all especially planned for the program by the Departments of English and History, and are taught by these departments. This procedure is typical of all the work offered for the six terms of the program between Contemporary Civilization and the final senior course. In each case a cooperating department of the Basic Division was asked to develop a course or courses to fit the program, and to teach it in close cooperation with those teaching the other work. A certain blurring of departmental boundaries will, we think, eventually result from this practice, and we feel that the educational effect will be healthy.

"Following the sophomore year of work in the humanities, all students in the program take a two-term sequence in economics. Besides meshing these courses with the rest of the program, the Department of Economics makes a particular effort to present clearly and objectively all the varied forces which affect the economic state of the world today, and to develop an analytical attitude on the part of the student.

"The third quarter of the junior year offers another choice. Either a course in sociology or one in political science may be elected. The sociology course gives special attention to the problems created by industrialization and urbanization, and points out the engineer's responsibilities and opportunities in modern technological society. The political science course analyzes parties and pressure groups in American politics . . .

"For the final course, two terms in length, the student is returned to the Department of Social Studies for a course entitled Contemporary Problems. As the description puts it, 'This course deals with several significant contemporary problems, utilizing in their analysis the relevant resources of the sciences, the social sciences, and the humanities. The purpose is to give the student practice and direction in the use of *all* parts of his education to help him understand and resolve the problems of his time. Readings are of two kinds: (1) basic analyses of the fundamental problems dealt with; (2) current news from the press, magazines, radio, etc. Special attention is given to a critical comparison of the various sources of current news and commentary, with a view to giving the student first-hand knowledge of how to get a balanced and unbiased view of current affairs.'

"Each term of the course in Contemporary Problems is devoted to the study of two general problems. For the academic year just ended, the four problems chosen were Freedom versus Authority, the Engineer and Society, Labor, Management, and Public Welfare, and War and Peace . . . Weekly lectures were given to large groups, and in the section meetings the material was amplified and discussed, and individual case studies were made by each student.

"Admittedly, the program [of general studies] exhibits a bias towards the social sciences: the classification of history as a humanistic study is debatable, and the content of our Contemporary Civilization course is at present largely history. We hope to remedy this unbalance, partly by giving greater consideration to the humanities in the first course and the terminal course, both of which we hope will eventually be unclassifiable, except as effective courses in general education.

"The entire program is under the supervision of a small committee, which includes in its membership the Dean of the Basic Division and one representative of the School of Engineering. The greatest individual responsibility is that of the head of the Department of Social Studies, who acts as chairman of the committee and who directly administers the Contemporary Civilization and Contemporary Problems courses . . .

"At this four-year point, the attitude of the instructors who teach the Contemporary Civilization and Contemporary Problems courses can best be described as one of infectious enthusiasm. They are, it goes without saying, thoroughly convinced of the importance of their work, and are effectively establishing the same conviction in the minds of their students. The department staff as a whole continually works toward the improvement of the courses; there is at present a spirited debate, for example, over whether Contemporary Civilization may not be becoming too largely a liberating course in the natural sciences, slighting our intellectual heritage in other fields . . .

"As for the School of Engineering, I think that I speak for my colleagues there when I say that we are happy over the successes of the program in

its first four years, and hopeful of its continued improvement and effectiveness. Our belief in the need for this phase of the education of our students has grown stronger since the inauguration of the work. Furthermore, we believe we are on the right track in our method of planning and administering the program. The advantages of having a detailed master plan, of having a committee charged with continual examination of the operation of the program, and of having a department created for the purpose of planning and teaching the first and the final courses in the program, have become manifest . . .

"Our second look reveals some unsolved problems, of course. We have fallen short of our objectives in the humanities: music, painting, architecture, and philosophy are in the program only as they incidentally appear in the freshman and senior courses . . . All in all, we like what we see."

At present the North Carolina program is undergoing a fundamental revision. Also an integrated program of general studies is proposed for the School of Agriculture. The unifying theme of this program is stated as follows:

"Throughout the four years of the sequence runs a dominant motif, and each of the courses may be regarded as a variation played on this central theme. The theme is the interrelationship between science and technology and social and humane manifestations of endeavor. We believe, first, that the use of such a framework makes practical sense for students whose main interests lie in scientific and technical fields; the social sciences and humanities thus become an integral and meaningful part of the student's total education. Secondly, we believe that this interrelationship has validity in its own right as a powerful means of understanding fundamental forces at work in the contemporary world."

The proposed courses are "Resource Use and Technological Development," (freshman); "Political and Economic Organization," (sophomore); "Contemporary Thought," (junior); and "Current Issues," (senior). An example of the thinking in this program is the outline given of the first semester of "Contemporary Thought":

"American civilization, hitherto treated in its historical, political, and economic setting, is shown here to be rooted in particular ideas about the ultimate meaning of Nature, Man, God, and the State. These ideas are in part the heritage of the great intellectual achievements of the 17th and 18th centuries, which are studied in terms of their conceptual framework, philosophic anchorage, and scientific validity. The student is shown that these achievements and their root ideas still underlie most of our present scientific assumptions and value judgments. He is made keenly aware, however, that significant departures from the earlier concepts and methods have occurred in recent times."

SOURCE READINGS: INTEGRATIVE MATERIALS AND METHODS

Understanding of Nature Increases The Scientist's Social Responsibility

Dr. A. J. Carlson of the Department of Physiology, University of Chicago, asked this question, "Does the greater understanding of man and nature increase the scientist's social responsibility?" at the meeting of the A.A.A.S. in St. Louis, December 30, 1952. The paper was reprinted in *Science, 117*: 701-703, 1953.

Man's social behavior for the past hundreds of thousands of years has been largely determined by direct experience, ignorance, and traditions based partly on ignorance. "We have now some indications that the voluntary behavior of all sane citizens can be directed toward the best interest of mankind through the understanding and acceptance of the nature of man and the universe, as revealed by modern science. The special social responsibility of scientists is to promote this understanding on the part of all people in all nations."

We need factual, scientific education on the nature of man that presents the evidence of the unity of the human race. The understanding of man requires more than science alone; it involves "man's environment and man's past, that is, history, sociology, economics, politics, literature, and even religion."

Dr. Carlson thinks that teachers underestimate the mental capacity of our average youths and fellow citizens. "They can learn, they can understand, they can even reason, if we the teachers can really teach by word, by demonstration, by example. But we must rekindle the suppressed *natural curiosity* in our students. . . . The student, the teacher in every field of education should ask for the *evidence*, should examine the evidence. We cannot defeat ideas with guns or bombs or mere say so. Bad ideas can be defeated with better ideas based on better *evidence*."

Cooperation among all peoples, conservation of our resources with intelligent planning for future generations, and assistance from those in biology and medicine in the working out of wise solutions to the serious problems of disease and over-population are among the urgent needs of our time. "It seems obvious that as a citizen the scientist's social

responsibility is at least as great as his understanding of man and nature. . . . So let us step down from our proverbial ivory tower and carry on!"

— Ruth Lofgren

Warm-Bloodedness: How Did It Develop And What Is Its Significance?

Dr. Simon Rodbard, Assistant Director of the Department of Cardiovascular Research of the Michael Reese Hospital in Chicago, reviewed the development and significance of "Warm-Bloodedness" in *The Scientific Monthly,* September, 1953, pp. 137-142.

The now-famous case of the woman in Chicago who survived exposure to extreme cold during which her body temperature dropped to 65°F indicates that the human body has the ability to function at temperatures far below the normal 98.6°F. The case has stimulated studies on the use of "artificial hibernation" in cardiac surgery and a search for more effective methods for the treatment of freezing and frostbite.

Some biologists consider the case to be a demonstration of the long-forgotten function of hibernation which certain primitive mammals still exhibit. This function is usually masked by the large variety of temperature-regulating mechanisms that have developed in the warm-blooded animals.

"In the course of the evolution of the higher animals and probably the higher plants and insects as well, there has been a progressive increase in the ability to withstand rapid environmental temperature changes. . . . It is well appreciated that variations in the environmental temperatures occurring during the course of the day in temperate climates play an important role in the cycles of activity of cold-blooded animals living on the land. During the day, absorption of the warmth from the sun raises the body temperature and increases the metabolic rate. . . . With evening, these cold-blooded animals, without the ability to retain heat, lose warmth to their environment. This leads to a slowing of metabolism, of circulation, and of general activity: the animal may fall into a sleep-like torpor."

The great bulk and relatively small surface area of the dinosaurs may have acted as a kind of passive warm-bloodedness. In the same period, certain reptiles that developed an ability to withstand large changes in temperature gave rise to the early mammals. Birds evolved more recently. They possess body temperatures higher than those of the mammals.

The development of heat-conservation mechanisms such as hair, feathers, shift of blood from the skin, subcutaneous fat pads, and mechanisms increasing the production of heat by shivering, etc. made the mammals relatively independent of their environmental temperatures. "The increasing efficiency of the heat-conservation and heat-production mechanisms finally brought about a new situation: the danger of raising the body temperature to critical levels. At this time, mechanisms resulting in a loss of body heat began to have survival value. These included reflexes that shunted the warmer internal blood to the surface; sweating, panting, and such positional changes as might reduce the intake of heat and increase the surface area exposed to the environment."

"The development of heat-conservation, heat-production, and heat-loss mechanisms introduced a new factor – the relative constancy of the body temperature. . . . These relatively constant conditions served to mask the basic integrative equipment, and the internal adjustments become minimal during the diurnal cycle." Dr. Rodbard listed a number of patterns of behavior of warm-blooded animals that suggest the retention of some of the elements of the daily temperature cycle of the cold-blooded animals: the diurnal variations in body temperature, blood pressure, heart rate, fluid shifts, and the period of sleep.

"The development of warm-bloodedness could not have taken place without the provision of an adequate supply of fuel and oxygen to maintain the fires of the body. The logistic problem was solved in the course of the long and involved evolution of . . . the complicated 'double' heart capable of generating the much higher blood pressures required by the warm-blooded animals. With these higher pressures, greater rates of blood flow can be obtained to supply the rapidly metabolizing tissues. These higher pressures also make it possible for animals to raise their heads skyward for the first time in history, since the pressure was now high enough to pump the blood upward against gravity."

The Promethean fire of warm-bloodedness has brought on us a Pandora's vessel containing high blood pressure, hardening of the arteries, and heart failure; but, as the author reminds us, it has also brought us Hope. *—Ruth Lofgren*

Globalized Universities Related to the World of Action

Dr. Cornelius W. de Kiewiet, president of the University of Rochester, has written an article entitled "Let's Globalize Our Universities" in *The Saturday Review* for September 12, 1953. This has been reprinted in the *News Bulletin* of the Institute for International Education for November 1953.

"American education is having trouble adjusting to the swiftness and magnitude of the change in our

world position," says Dr. de Kiewiet, who points out that higher education in this country has been far more adjustable and given to innovation than anywhere else.

". . . . This is a plea that a resolute effort be made to correct our dangerous illiteracy in the life and thought of great areas of the world where history has begun to roll at such a pace that the things on which we place greatest value . . . are intimately affected. Illiteracy in science and technology is much less dangerous for the citizen of a democracy than illiteracy in history or politics or morality . . ."

After reviewing the dimensions of the revolutionary forces that are loose in the world, particularly that vast part of the world which is not included in what we call (and teach as) "western culture," Dr. de Kiewiet warns that "America's consciousness of its world must undergo the same transformation that occurred in Western Europe in the sixteenth and seventeenth centuries as a result of the great voyages of discovery . . . By remaining ignorant and illiterate we are simply multiplying the chances of being wrong in a big way in our relations with a world in revolution."

Many large universities have subsidiary institutes for the study of other cultures. These the author believes are not enough, as they ". . . have largely joined the trend of the graduate schools towards specialization, and away from the broad learning of the good liberal arts curriculum . . . Only an unusual effort backed by real courage, will bring about the reassessment of the undergraduate curriculum . . ." which is required in this crisis.

His suggested scheme is very interesting: "Reassessment, however, means broadening, not the addition of new specialties; not to see people through the eye of a needle, but to gain a perception of their nature, the flowering of their art, their answers to the problems of good and evil, their careers amid the great forces of climate and history, their hopes for the future. It means the respectful making of room, even at the expense of condensation or restriction elsewhere, to enable students to learn some fundamental things about several billion very important human beings . . .

"It is of the greatest importance that we do not see the new materials, or courses which are here recommended, as simple additions or replacements. Unless they are also seen and accepted as a new ferment, a new modifying substance within our intellectual environment, they will do no more than crowd the curriculum and irritate faculties . . .

". . . A merely passive spectatorship of our uneasy world is unethical," Dr. de Kiewiet concludes. "The humanities today cannot be a shelter from the world of action. If scholars refuse to admit this, they must not be unhappy if the world of action ignores them." —*Harvey W. Culp*

The Concept of Individuality In Biological and Social Sciences

One of the most important integrative concepts of the biological and social sciences is that of "the individual." M. Jeuken S. J. of the Zoology Laboratory at Leyden presents a development of "the concept 'individual' in biology" in *Acta Biotheoretica, 10*(½): 57-86. 1952.

"The concepts of individual and individuality are examined in order to arrive at a definition that satisfies the scientific conscience. From a discussion of what are the ideas of such representatives of various schools of thought as Haeckel, von Bertalanffy, Driesch, and Bergson, it appears that in the matter of individual and individuality there are so many points of agreement, that we are justified by induction in seeing in those agreements the essential contents of the concept of 'individual.' These elements are: subsistence, unity and totality, tendency toward a closed system, and the impossibility of a full definition. They are successively discussed, and as a result the following definitions of a dynamic, not a static, character are proposed: individuality is the tendency of the single organism towards undivided subsisting totality. A being is an individual in the measure in which this tendency is realized. The application of this dynamic concept is illustrated by some examples taken from the system and from ontogenesis." (As reviewed in *Biological Abstracts, 27*(4): 1953, by the author, M. Jeuken S. J.)

The Action of Living Matter As a Problem of Chemistry

Many biologists rebel at attempts to explain life processes in terms of the concepts and principles of physics and chemistry. *Das Lebendige als Problem der Chemie* (Living matter as a problem of chemistry) was discussed by Kurt Sausgruber in *Wissensch. und Weltbild 5*(8): 285-288. 1952.

"Living atomic structures are characterized as governed by an unstable dynamic order of ectropic tendency, while all non-living matter tends toward entropy. This principle of order must thus accumulate free energy with the aid of labile-dynamic structures, differing from all other principles of order in that its effects are not measurable by physical methods. Thus it must act by a "non-energetic" path, i.e., inaccessible to physics and chemistry. Nature, thus, has not only atoms but also entelechies." (As reviewed in *Biological Abstracts 27*(5): 1953.)

REVIEWS

New World of the Mind: Its Meaning for Our Time

Many readers will doubtless expect that *New World of the Mind,* by J. B. Rhine (William Sloane Associates, N.Y., 1953, $3.75) will be either a presentation of new materials in the field of parapsychology or a further discussion of the justification of the research in this field. This is true only for the first three chapters. Here the author again presents "A [general] Chart of the Areas discovered," a discussion of the "Claims, Challenges, and Confirmations," and a quick review of "The Present Research Frontiers" in the realm of psi. As a general statement of the work in this area of human experience and knowledge, these three chapters should serve as an excellent introduction for those who have not previously followed the research results and their justification, which can be found in more detail elsewhere.

This book is significant in another way from chapter IV to the end. It should provide stimulating reading for both those who are convinced and those who remain unconvinced as to the proven validity of psi phenomena. In this major portion of the book, the author explores the relation and significance of psi phenomena to other areas of natural science and to human life. Psi phenomena appear to demonstrate the existence of a non-physical force inherent in all human beings (no correlations with race, sex, intelligence, or other factors having been found) at a very deep unconscious level. The difficulty which most people experience in accepting the finding arises from the fact that it just does not fit into our present physical concept of nature. Those who can accept the existence of a non-physical force will therefore find the discussion in these chapters to be an exercise in the expansion of vistas made possible for an array of disciplines by the extension of a concept new to them. This reviewer urges those who cannot accept the present findings yet to give themselves this same experience. Surely, it should be possible for them to control themselves long enough to see what might happen to science and to life on the basis of "just suppose such a non-physical force were to exist."

Not only would our concepts as to the nature of the physical universe undergo a radical change, but biological sciences would be given a new approach to the unsolved problems of organization, morphology, self-dimensioning, and the central problem posed by the nature of life itself. Even naturalists could attack (as some are attacking) afresh the problems of homing and migration in birds and animals.

As has already been indicated, Rhine and others demonstrate that psi is a phenomenon of the deep unconscious. Its relationship to other problems and mysteries in psychology is indeed very intimate. No satisfactory explanation can yet be given for mind-brain relationships, for subject-object transactions, for the organization of figure-ground significance, etc. These and many other puzzles at the core of human life await new concepts. Perhaps, as Rhine suggests, psychology can be released from the thrall of mechanistic physiology by giving it a field of reality which is peculiarly its own.

The implications for religion, morals, ethics, mental health, and the general conduct of human life are explored. Belief in the validity of psi should not be a factor in determining whether a person should read these important chapters.

Finally, anyone who values human freedom and dignity, who is concerned over the state of the world in this era of cold wars, of suspicion, of witch-hunting, and such, should read chapter IX of this book at all costs. Here, with courage and vigor (and with a skillful pen) the author points to the debilitating effects of materialistic and physicalistic concepts upon our own way of life in parallel to their devastating effects in communism. This chapter is one of the most biting analyses of the present world crisis that we have encountered. It is to be hoped that every educator, every clergyman, and every journalist shall read and inwardly digest this chapter. It is also hoped that this chapter at least can receive wide circulation in Washington and our state capitols and someone should insert it as "extended remarks" in the Congressional Record. —*Harvey W. Culp*

Integrative Knowledge and Action In Operational Philosophy

Operational Philosophy, by Anatol Rapoport (Harper & Brothers, N.Y., 1953, 224 pp., index, glossary, notes, biblio., $3.75) is subtitled "Integrating Knowledge and Action." Here, the Assistant Professor of Mathematical Biology at the University of Chicago and Associate Editor of *ETC: A Review of General Semantics* builds an integrative philosophy which should be carefully examined and appraised.

As defined by Dr. Rapoport, ". . . operationalism is *being aware* of the way of science – the philosophy of science. In the old days," he notes, "science *was* philosophy." But, about the time of the Renaissance, the union of "know how" and "know why" can be taken as the beginning of the scientific age – and science and philosophy went their separate ways. At the turn of the present century, a new intellectual outlook was needed, so science created its own philosophy, reflecting ". . . a growing preoccupation of science with *itself* . . . [and] . . . out of such self-awareness, particularly in the light of the new theory of meaning (semantics), operationalism has crystallized.

"The newest developments, particularly in the United States, are attempts to extend operationalism so as to make it a method for dealing with human affairs. . . . The existence of such a climate is of prime importance in our day when public opinion

has much more weight than formerly in influencing educational policies."

Part I of this book, which is devoted to the problems of definition, of reality, of verification, of deduction, of causality, and of the frameworks of thought, will be difficult for many readers but, however difficult, the insights given are sure to be rewarding.

Part II, entitled "Operational Ethics," consists of six chapters on choice, ends and means, types of value systems, operational ethics, individual and society, and "communication, power, and revolutions." Under operational ethics one finds an intriguing discussion of freedom and determinism. Concluding this part, the author summarizes by stating that ". . . the basic invariant ends of man are not subject to ethical discussion, because *we have no choice* but to pursue them. They can, however, be determined by a scientific investigation (just as physiological needs are so determined). The proper subject matter of ethics is the *choice* of means to pursue the ends. Such choice is determined by one's action-orientation. At the center of operational ethics, therefore, is the scientific (objective) study of such orientations. This study, however, *itself* influences the action-orientation in that it frees men from compulsions which are at the root of out-dated orientations (the ethics of retribution, the ethics of compulsive activism, etc.). The important result of applying science to ethics, then, is not that science enables us to decide which ethics we should choose but that the practice of science already leads us toward the operational ethical system."

The joining of "communication, power, and revolutions" in a chapter heading may seem strange but the choice of the terms is dictated by the author's needs in discussing the question, "How does a society (a quasi-biological organism) maintain its integrity when it does maintain it?" Here is an excellent review of the importance of communications and information to and among a people, of delegated and undelegated powers, and of the "open society." This is important reading at this juncture in our American history.

Part III deals with quantification: quantification of validity, truth, and causality; of order, of life and of ethics; the extensional bargain; metaphors and models; and "the philosopher's job."

We wish it were possible to quote here many of the stimulating and vista-opening passages in this part of the book. The author's discussion of life in terms of negative entropy is well worth any effort which the preceding 185 pages may have required!

Indicating the integrative trend of the present, Dr. Rapoport assures us that "At present the domain of quantified description of events is rapidly increasing and spreading into the very areas which have traditionally been considered as unyielding to quantitative (or any kind of objective) description. The importance of this trend is that it indicates the possibility of coming to terms in any discussion by translating the discussion into a language in which evaluations are least influenced by subjective states and emotional commitments."

Here, altogether, one will find an encouraging and courageous philosophical foray into realms which have in the recent past been discussed only partially by the semanticists and the cyberneticians *as specialists* and given a "once over lightly" by the logical positivists. These times and our present problems demand more of us than we have been able thus far to give. This reviewer believes that, in this book, Dr. Rapoport has done us service in setting us on our way. —*H.W.C.*

One of the most difficult and yet most vital problems we face today is that of communicating the essential integrative concepts of each field of knowledge to the young people of our time in language they can understand and in a style they will find interesting. The story of international co-operation, *World in the Making,* by James Avery Joyce presents the concept of unity of mankind as it has developed with civilization from the beginning of human history. The book is well illustrated by Bunji Tagawa. (Henry Schuman, Inc., N.Y., 1953, 159 pp., $3.50.)

Mr. Joyce has a simple, charming style in which he "opens before us — scene by scene — the most wonderful story in all creation. It is the ageless drama of how man, by stretching out his hand toward his fellows, ceased to be a lonely savage in a forest clearing and became a citizen of the world, with all the nations of the earth as his next-door neighbors.

"The past has to teach that *every* country and *every* people has had some important part in bringing about a united world."

The ways in which the institutions and customs of the various cultures developed as the peoples of the world strove to satisfy their needs for Food, Freedom, and Friendship make a fascinating tale as told by this most able story-teller.

World in the Making is full of slogans that contain the force of the author's thesis: "Civilization is Cooperation," "Good communications may bring men together, but only good citizenship can keep them together."

The book ends with an excellent review of the plans for peace, the international institutions now functioning effectively, and a frank challenge to the peoples of the world today to make peace a reality through accepting the privileges and obligations that accompany a sense of world citizenship.

—*Ruth Lofgren*

The Tarner Lectures for 1949-50 were given by J. H. Woodger, and appeared as *Biology and Language* (Cambridge University Press, 1952, 356 pages and index, $8). The book is primarily concerned with a suitable language for discussion of biology, and only secondarily with the subject matter, life. It follows Woodger's technical works, *The Axiomatic Method in Biology* and *The Technique of Theory Construction,* and moves away from the thinking in *Principia Mathematica* toward Boole and Frege.

For many general readers this book will probably be as discouraging as it may be for some biologists. It constitutes an attempt to devise for biology the same

closely exact type of discourse that can be had in physics and chemistry, including biology equations no more mathematical than are many chemical equations. The author is conversant with all aspects of the vast fields that must be drawn upon for his purposes. Even though his work constitutes only a review and arrives at none of the utter simplifications (such as $E = mc^2$) which inspire and unite technicians and laymen in physics, it will have much effect, through the reflective readers who will use it. The lay reader must be warned (as Woodger does warn him at the very start) in Shakespeare's words (in King Henry VI, Part 2, IV, vii): "It will be proved to thy face, that thou hast men about thee, that usually talk of a noun, a verb, and such abominable words, as no Christian ear can endure to hear." It is rather disconcerting, when most we need simplification and common understanding, to read of matrices and quantifiers, the mating function, and Cartesian dualism. But we must have men able to formulate the issues before we can get clear the primitive assumptions which lead to simplicities and new orders. Let us recall the mechanistic jungle which darkened physics before Einstein, Planck, Minkowski, and others cut through; or the complex in chemistry before Mendeleyeff and others set to.

The lay reader, although the book is not for him, will find a wealth of perfectly straightforward and priceless data and ideas. Let him read, for example, Woodger's discussion (pages 301 to 315) of Dr. Ian Suttie's book, *The Origins of Love and Hate,* (Kegan Paul, London, 1935), and he will see that the author is actually getting at the fundamentals and that the lingo and the symbols of functors, zero-levels, and will sets, drawn from Boole, Russell, Tarski, and others, and those newly devised, are not used by a clever man to darken counsel, but are instruments devised by one of our greatest living biologists to help us get at something we do not have, and much need: a philosophy for biology, as such. —*F.L.K.*

In these days when the major battle for freedom is being fought in education, at all levels, *Elementary School Objectives,* a report prepared for the Mid-Century Committee on Outcomes in Elementary Education by Nolan C. Kearney (Russell Sage Foundation, New York, 1953, 181 pages, index, $3) is mainly a useful review of what is. In this aspect it is rounded, brief, and contemporary, and covers a big territory with eminent fairness. The final fifty pages are given over to the implications (or, what might be) for practice in schools and public, for educational research and theory, and for measurement. Laissez faire, essentialist, and reconstructionist are referred to (p. 156), but the author writes of them: "They are over-simplifications. They beg many troublesome questions of meaning and value." For those who mean to confront those questions, here is an admirable and manageable summary of the present situation, at each major age-level into high school.

Another useful review of what is going on in elementary and secondary levels will be found in *Curriculum Trends and Teacher Education,* 32nd yearbook of the Association for Student Teaching (available from Allen D. Patterson, Secretary-Treasurer, State Teachers College, Lock Haven, Pennsylvania, 1953, 254 pages, no index, bibliography, price not stated). Twelve teacher training colleges are reviewed.

Aroused defenders of the school system should read, as a sample, Chapter IV, which summarizes what Western Washington State College (in Bellingham) is called upon to do. In 1925 the then one-year normal schools became two-year colleges. They offer now essentially six-year courses. State education departments in many states have done valiant work in getting into a position where they can rest democracy on a more than literate electorate; and the state colleges have risen to the need in respect to training. But it is notable that in educational philosophy no comparable efforts to get at essentials of method have been as yet made. At Western Washington State College social and philosophical foundations get major attention only in the fourth year. Surely this is belated and inadequate?

The colleges are aware of this. At Iowa State, "for many years the tendency in the study of man's activities has been for greater segmentation with resultant loss of unity. The integrated humanities course represents an attempt to capture in a measure, that sense of unity." (page 214) Why only "in a measure," and in a sense? The answer is the usual one: the cultural meaning, criteria, contents, and consequences of the sciences are not in the integrative process. When will the teachers' college association awaken to this fatal defect? —*F.L.K.*

Mentor Books now include, at 35¢, yet entire, *The History of the World,* by René Sédillot in 240 pages of text and 14 of index, and at 50¢ George Gamow's *One Two Three . . . Infinity,* 314 pages and 4 of index, with about 128 illustrations. It is encouraging to see items such as this reaching multitudes of people, in most readable type, yet pocket size. The publisher is The New American Library, 501 Madison Avenue, New York 22.

We would like to see one of these great distributors prepare and publish a short series of books, not texts and not popularization, on the *philosophy, psychology, history,* and *science* of some *basic* subject, say, arithmetic, geometry, and higher mathematics. By this we mean the fundamentals found divided between texts and general work (in some particulars) available in print nowhere. We venture to say there would be an immense sale for such a series, and they would help the sales of other works, such as this book of Mr. Gamow. Is a line real? For example, does the earth's polar axis exist, or do we "only imagine it"? What is reality? The seemingly innocent questions are profound. They are at the base of our current philosophical confusion, and our irresolution. They are fascinating, and, being simple, could be made to reach a great public.

In a recent issue of MAIN CURRENTS, VOL. 10, No. 1, p. 12, reference was made to indigenous Indian medicine. We have since received the second edition of *The Science and Art of Indian Medicine,* by G. Srinivasa Murti (Adyar Library, Madras, India, 196 pages, Rs. 3), previously reviewed in these pages. Dr. Srinivasa Murti was an officer in the Indian Medical Service, with the rank of captain, and is also expert in the philosophy and science of the Eastern system (Ayurvedic) medicine.

We know of no work in English in which the ardent student of Indian science and thought will find a comparable compact and essential knowledge with which the two medical systems, Eastern and Western, are compared. —*F.L.K.*

NEWS AND NOTES

1954 Foundation Workshop:
Preliminary Announcement

It is expected that announcement of the program of the eighth summer, 1954, workshop of the Foundation for Integrated Education will be found in the next issue of MAIN CURRENTS. We make the present preliminary mention so that those of our readers who are beginning to plan their summer will be alerted.

A cordial invitation has been received by the Foundation from Wisconsin State College, Milwaukee, to offer this program during their summer session. It would thus be available not only to participants who attend for this event alone, but to the summer school students of the College as well, possibly for academic credit.

The Workshop session would occupy a week, and fall somewhere between June 21st and July 29th.

We are proposing to concentrate the sessions upon several aspects of the question of teacher education for integrative studies. The program will presumably include discussion of changes called for, especially in teacher education for the secondary school. Some of the changes required in high schools were discussed by Herbert G. Espy, Commissioner of Education, State of Maine, at the 1953 Workshop of the Foundation, co-sponsored by the University of Maine. (These were reported in Vol. 10, No. 2 of MAIN CURRENTS.) Concrete proposals for correctives will come forth in 1954.

The Foundation will bring some of its own experienced colleagues to the workshop, and we shall hope to draw as usual on colleges and universities in the region (including the co-sponsor) for aspects of special importance calling for technical competence.

A final decision on this proposal can be made only in February. If affirmed, this will be the first Workshop the Foundation has been privileged to offer in a north mid-Western state.

Readers of this note who would like to have particulars as to dates early may write immediately, as the program will be ready in draft form well before the next issue of MAIN CURRENTS.

There is reason to notice here, instead of in our review columns, two recent publications in the Josiah Macy, Jr. Foundation series of multiprofessional conference transactions upon psycho-physiology. The volumes are not definitive works but reports of informal discussions, based upon organized oral or visual presentation of some aspect of the topics into which the conferences are broken up.

The books before us are: Transactions of the Third Conference on *Problems of Consciousness,* March 10 and 11, 1952, edited by Harold A. Abramson, M.D. (155 pages and bibliography, price $3.25). The contents include Consciousness and the metabolism of the brain, Hypnotic phenomena, and Experimental work on sleep and other variations of consciousness. The second volume comprises Transactions of the Ninth Conference on *Cybernetics,* Circular Causal and Feedback Mechanisms in Biological and Social Systems, March 20 and 21, 1952, edited by Heinz von Foerster (181 pages and references, price $4.00). The contents are: The position of humor in human communication, The place of emotions in the feedback concept, Homeostasis, Discrimination and learning in octopus, Reduction of the number of possible Boolean functions, Central excitation and inhibition, Mechanical chess player, Turbulence as random stimulation of sense organs, Investigations on synaptic transmission, Feedback mechanisms in cellular biology.

It should be obvious from the subheadings of the title of the second volume, and from the tables of contents of both, that the material here made available is precisely of a kind indispensable to those teachers of general education courses who meet and continuously discuss integrative (i.e., philosophical) education. Through such discussion, they will be able to study aspects of the rapid shift going on in the philosophy of science. There are general education faculties which have abandoned project integration (that is, mere coordinated effort to solve practical problems) and are discontented with breadth, unless a wide scope be so treated as to deepen insight. Such groups usually contain biologists, psychologists, mathematicians and other professionals perfectly capable of employing these conference transactions.

In the two current volumes under consideration they will find basic topics for the philosopher raised in terms of specific instances. See, for example, pp. 155-158 of the *Cybernetics* volume, where the discussion, conducted by G. Evelyn Hutchinson, is concerned with turbulence as a random stimulation of sense organs in tiny marine and freshwater plankton, the growth of whose helmets is dependent to a considerable extent upon the turbulence of the water in which they live. The essence of the matter is surely the ancient problem of the relation of functional order to the heterogeneity of the environment — the problem of organization and entropy, of meaningful figure and ground. This problem is as old as cultural thought.

Another example occurs at the very end of the discussion of *Problems of Consciousness,* relating to dreams. We reproduce the text (pages 153-154):

"Abramson: . . . Patients bring in the most elaborate descriptions of dreams in which it ap-

pears to me that there are a large number of different types of sensorial impressions, all of which, of course, are visual memories. However, there seems to be a different type of integrative function occurring during sleep, which is localized in a way that I am not aware of. This integrative function must be on a level with the highest type of integration because complicated mathematical problems can be performed in a dream. It is my impression that during the processes connected with dreaming a lot of the difficulty which we have when awake with being conscious of things in a symbolic way, in a personal way, disappears. Just how or why, I don't know. Perhaps it is not so. I have no way of proving it.

"Barry: Let us accept for a moment the report that the person while in a dream was able to be attentive to both visual and auditory stimuli. These stimuli did not come through the sense organs.

"Abramson: Oh, no, it has nothing to do with the sense organs.

"Wright: I like Dr. Abramson's statement that he thinks perhaps the dream should be considered as a different and highly integrated state of consciousness . . . not unconsciousness. I take strong exception to the view that sleep can be considered unconsciousness. . . . We have been speaking about sleep as if it could be equated with unconsciousness.

"Kety: Some data given yesterday might have indicated a difference between the two . . .

"Monnier: I would certainly agree that sleep must be considered as a state of partial consciousness. Some integrative activity of the cortex is still present in sleep, but certainly not to a high degree. The highest level of cortical integration and of consciousness is apperceptive logical thinking.

"Fremont-Smith: There is the question of what is meant by 'highly integrated.' Sleep is not a disintegrated state but one involving a different state of integration . . .

"Mead: . . . A very nice study has been done on dreams in three different primitive societies (Stewart, K. *God in the Cellar,* unpublished ms.). In one of the groups, people are taught to dream. Dreaming is a part of their social behavior. A child tells his dreams every morning and they are criticized by the older men, who tell him they don't think much of a particular dream and suggest he should have done more with it. Thus, there are certain people who learn to dream in an organized and disciplined fashion. Something of that sort may occur in analysis when individuals are taught to do more with their dreams than they do ordinarily."

Limiting comment to one older, non-primitive culture, we may remind readers that in this necessarily introspective form of science observers in India established far-reaching significance as to the human psychological constitution in terms of waking consciousness (*jagrat*), the dream state (*svapna*), dreamless slumber (*sushupti*), and, especially in the hands of Shankaracharya, a fourth (*turiya*) state of deep insight, *samadhi.*

We mention these obvious connections to indicate how western frontier thought is furnishing concrete examples of data which, especially in psychology, make rapport with the East and classical European antiquity possible on an evidential basis. It thus helps to retard the alarming rise of anti-intellectualism in this country.

In the volume on *Problems of Consciousness,* about half is devoted to discussing consciousness and the metabolism of the brain, led by Seymour S. Kety. Dr. Kety takes the position, now so common, that biological processes can best be treated as mechanical systems, but that consciousness is sui generis, and has special effects upon psyche. Hence the problem is to determine which parts of mental activity are anchored to consciousness, and which features are correlates of organism. Since the essential nature of consciousness remains undetermined, and since experimentation upon the physical organism's structure and behavior is not too difficult, the discussions naturally tend to support mechanism.

It is, perhaps, pertinent to suggest that a more generous draft upon the cultural experience of the human race would help to keep proportion in these areas where of necessity we must observe and cannot experiment under controlled conditions. The discussion (pp. 145-148) of the limitation of awareness to one sense report at a time confirms the view that although the organism can be, and obviously always is, doing many things at any one instant, consciousness can attend to but one report at a time. For the Hindus (as for Leibnitz) this observation led to the conviction that consciousness per se is a point-atom, a monad, *atman.*

The Josiah Macy, Jr. Foundation is putting us all under a very real debt of gratitude to them for getting these groups of unusually well-equipped specialists together, and reporting their proceedings verbatim. The participants are also to be thanked for hunting down the sources of their disagreements. We should all profit if similar conferences could be set up in, say, biology, on the line (for example) between genetics and development, and on the frontier of possible biological field theory. It is likely that discussions here would prove an important challenge to unwarranted extensions of mechanism. —*F.L.K.*

Dr. Howard L. Parsons has been so good as to allow us to print by itself the concluding portion of a discerning and delicately expressed discourse, entitled "A Definition of Freedom." It will be found elsewhere in this issue.

We permit ourselves an editorial comment. Parsons is dealing with what may be fairly described as *the* issue of our day: the increase of neurosis,

and the contributions of education to this truly terrifying phenomenon. The central question is, what, basically, does modern man fear? We recommend an unusually close reading of the discussion in the article under reference.

Freedom is a function of order and not of chaos. The sense of freedom which comes from ignorance is surely not to be confused with the knowledge called for if freedom is to be enlarged? A man is not free to fly until he knows the laws governing flight, and uses them. No amount of jumping from house tops with flapping arms and shouts of freedom will end in anything but disaster.

The modern problem arises from the fact that we do not know the orders of nature, in respect to those levels of experience which have their actuality in forms not directly expressed in physical terms. What are the laws of the mind, which lead to mental freedom? What are the laws of the emotions, which will free them? The answers to such questions are, as of today, mere silence. What is more, if there should be environments for psyche (as modern psychology and sociology powerfully indicate), how are we to know the laws of those environments as they are in themselves, and not merely as shadows cast in this world?

The neurotic wants security. But it should be obvious that there is no security except in those orders of nature which constitute the intelligible universe. Our basic fear is thus a function of ignorance, and the fact that we cling to the false supposition that security may be found in the flux is rooted in our refusal to recognize that each of us is alone with the universe. That thought is not so terrifying, if we feel there are indications that the universe is so charged with order that it ensures justice and freedom.

A grave charge can be levelled at modern education. It has been far too slow to realize that citizens in a democracy must base their convictions of human dignity upon *demonstrable* order, not just on hope or hunch. Therefore it is for education to teach with such compelling effect that each may grow confident that, although he is indeed alone in respect to the flux (and even in respect to his fellow men, for who can understand us in our private lives?), he is alone with an ordered and just universe which has produced him, as an individual, for some great purpose. As it is, we teach that evolution has been systematic, and phyla persistent, and life fair and generous, and that though nature is prodigal of individuals produced in over-abundance, she uses these excess quantities in an interactionism which ensures that types will persist. So much is certain, up to the coming of man on the scene.

Here occurs a fatal misapprehension. We do not adjust our thought to the overwhelming significance of the fact that human consciousness is an individual possession. That is to say, the next great gain in evolution, self-consciousness, is made on terms the reverse of all that went before. Man's uniqueness in the evolutionary series is possible only because it is today at last enshrined in the individual, whatever the self-consciousness potential may later prove to be.

Neo-Darwinian assumptions ignore this. That which is man's mark, the result of the long paleontological gestation which made him possible, has to be prized where and how it occurs. This makes the human individual as important at its level as the phylum has been in prior evolution. Shapley and others have shown that on a very conservative statistical basis thousands of planets with man-like inhabitants must be supposed. Far from making our cosmology bleak, such a concept, we contend, demonstrates a natural order so vast that it must embrace even free-seeming man. Therefore we should not state our notions of freedom in terms of our present ignorance of natural order. Let us rather first ask how many levels there may be in our multi-dimensional universe in which orders can be arrayed, upon evidence. With that much in hand we can begin to ask what freedom for man really is.

Let us repeat: This will involve the abandonment of some old and cherished fallacies. As Einstein has pointed out over and over, the sublime order of the universe is the basic notion of deity which our modern ideas authorize. A personal deity (or, more exactly, an explanation of personality) is to be looked for in such terms. It is true that some conspicuous American teachers, such as Dr. Mortimer Adler, want the sequence reversed. They are making an impractical suggestion. In the evolutionary series, natural law made species possible. Species did not manufacture natural law. However, behind Dr. Adler we may notice the nostalgic individual whose idea of deity is pre-Copernican – the individual who cannot endure the thought of the modern universe. To him deity may still be confined to some local intelligence, limited in benevolence to those causes with which he is himself sympathetic. There is no use pursuing the argument with such people, for they rationalize their emotions instead of reasoning from facts. But to others, less personally attached, much may be said that will ease the dilemma into which the apparent (never real) dichotomy between scientific law and human values has thrust them.

And we surely must try to resolve the dilemma on a larger and more important scale, by directing our efforts toward the knowledge of noble and enduring orders. It is this, over the long haul, which can put an end to the bases of neurosis in the fictitious search for security in the flux. Integrative education in the orders of the universe alone will encourage men to stand upon their human dignity and worth, accepting their role as the final statement (to date) of an evolution which operates upon an order so exquisite that it must give rise to justice and freedom.